CLAIMS:

We claim:

1. A polymerization process comprising combining ethylene, at least one C_4 to C_{12} α-olefin and a catalyst system comprising a polymerization catalyst and an activator; wherein the activator comprises a heterocyclic compound, which may be substituted or unsubstituted, in combination with an aluminum containing compound; wherein the aluminum containing compound is an alumoxane or an alkylaluminum compound represented by the formula AlR_3 wherein each R is independently a substituted or unsubstituted alkyl group.

2. The process of claim 1, further comprising a support material.

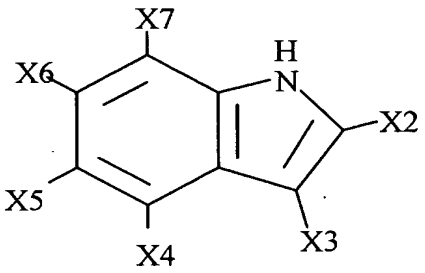
3. The process of claim 1, wherein the heterocyclic compound is selected from the group consisting of pyrroles, imidazoles, pyrazoles, pyrrolines, pyrrolidines, purines, carbazoles, indoles, phenyl indoles, 2,5-dimethylpyrroles, 3-pentafluorophenyl pyrrole, 4,5,6,7-tetrafluoroindole, 3,4-difluoropyrroles, and combinations thereof.

4. The process of claim 1, wherein the heterocyclic compound is substituted with one or more substituent groups selected from the group consisting of a halogen atom, and a halogen atom containing group.

5. The process of claim 4, wherein the halogen atom or the halogen atom group comprises chlorine, fluorine or bromine.

6. The process of claim 2, wherein the support material is treated with the alumoxane or the alkylaluminum compound such that the support has aluminum alkyl groups bonded thereto.

7. The process of claim 1, wherein the heterocyclic compound is an indole represented by:



Formula (I)

wherein each of X2 to X7 is independently selected from the group consisting of hydrogen, halogen, an alkyl group, a halogenated or partially halogenated alkyl group, an aryl group, a halogenated or partially halogenated aryl group, an alkoxide group, a halogenated or partially halogenated alkoxide group, an aryloxide group, a halogenated or partially halogenated aryloxide group, an aryl substituted alkyl group, and a halogenated or partially halogenated aryl substituted alkyl group.

8. The process of claim 7, wherein the halogenated or partially halogenated group comprises a chlorine atom, a bromine atom or a fluorine atom.

9. The process of Claim 1, wherein the activator is represented one of the following formulae:

(a.) $(R'_x M (JY)_y)_n$

or

(b.) $[((JY)_y R'_x)_n M–O–M ((R'_x (JY)_y)_n]_m$

or

(c.) $(OMR'_x(JY)_y)_n$

wherein M is a Group 13 atom;

(JY) represents a substituted or unsubstituted heterocyclic group attached to M, wherein J represents at least one heteroatom contained in the (JY) group;

n is 1 or 2 in formula (a.); n is 2 in formula (b.); and n is a number from 1 to 1000 in formula (c.);

m is a number from 1 to 10;

x + y = the valence of M in formula (a.); x + y = the valence of M - 1 in formula (b.); and x + y = valence of M - 2 in formula (c.);

each R' is independently a substituted or unsubstituted alkyl group bonded to M.

10. The process of claim 9, wherein J is bonded to M and wherein (JY) is not perhalogenated.

11. The process of claim 9, wherein

M is Al or B; and

(JY) is an substituted or unsubstituted indolyl group where the substituents are selected from hydrogen, halogen, an alkyl group, a halogenated or partially halogenated alkyl group, and aryl group, a halogenated or partially halogenated aryl group, an aryl substituted alkyl group, a halogenated or partially halogenated aryl substituted alkyl group.

12. The process of claim 2, wherein the support material is an Group 2, 3, 4, 5, 13 or 14 metal oxide.

13. The process of claim 2, wherein the support is silica.

14. The process of Claim 1, wherein the polymerization catalyst is a bulky ligand metallocene catalyst having the formulas:

$$L^AL^BMQ_n \text{ and } L^AAL^BMQ_n$$

wherein each of L^A, L^B and Q are bound to M;

each of L^A and L^B are substituted or unsubstituted cyclopentadienyl ligands or cyclopentadienyl-type ligands;

M is a Group 4, 5 or 6 transition metal;

Q is a leaving group; n is 0, 1 or 2; and

A is a divalent bridging group bound to each of L^A and L^B.

15. The process of Claim 1, wherein the polymerization process is a gas phase process.

16. The process of Claim 1, wherein the polymerization process is a slurry process.

17. The process of Claim 15, wherein the reactor temperature ranges from about 60°C to about 115°C.

18. The process of Claim 15, wherein the reactor pressure ranges from 100 psig (690 kPa) to about 500 psig (3448 kPa).

19. The process of Claim 15, wherein the reactor pressure ranges from 200 psig (1379 kPa) to about 400 psig (2759 kPa).

20. The catalyst system of Claim 1, wherein the catalyst system is combined in a polymerization reactor with the olefins to produce a polyolefin having a melt index ranging from 0.01 to 100 dg/min and a PDI (Mw/Mn) value of greater than 1.5 to 15.

21. A polymerization process comprising combining ethylene, at least one C_4 to C_{12} α-olefin and a catalyst system comprising a polymerization catalyst, an inorganic oxide support and an activator; wherein the activator comprises a heterocyclic compound in combination with an alkylaluminum compound represented by the formula AlR_3 wherein each R is independently a substituted or unsubstituted alkyl group;

wherein the heterocyclic compound comprising at least one atom selected from Group 15 or 16 of the Periodic Table of Elements; and

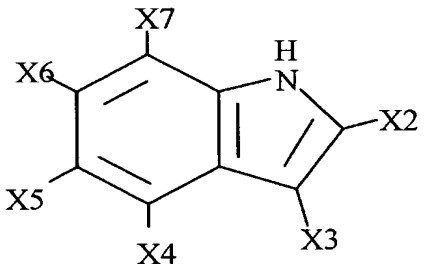
wherein the polymerization catalyst is selected from bulky ligand metallocene catalysts, Group 15 atom containing polymerization catalyst compounds, and phenoxide transition metal catalyst compositions.

22. The catalyst system of Claim 21, wherein the support is selected from silica, fumed silica, alumina, silica-alumina, zeolites and mixtures thereof.

23. The catalyst system of Claim 21, wherein the R groups are independently selected from C_1 to C_{30} alkyls.

24. The catalyst system of Claim 21, wherein the alkylaluminum is selected from trimethylaluminum, triethylaluminum, triisobutylaluminum, tri-n-hexylaluminum, tri-n-octylaluminum, tri-iso-octylaluminum, triphenylaluminum, and combinations thereof.

25. The catalyst system of Claim 21, wherein the heterocyclic compound is an indole represented by:



Formula (I)

wherein each of X2 to X7 is independently selected from the group consisting of hydrogen, halogen, an alkyl group, a halogenated or partially halogenated alkyl group, an aryl group, a halogenated or partially halogenated aryl group, an alkoxide group, a halogenated or partially halogenated alkoxide group, an aryloxide group, a halogenated or partially halogenated aryloxide group, an aryl substituted alkyl group, and a halogenated or partially halogenated aryl substituted alkyl group.

26. The catalyst system of Claim 25, wherein each of X2 to X7 are independently selected from hydrogen, fluorine, chlorine and bromine.

27. The catalyst system of Claim 21, wherein the heterocyclic compound is selected from the group consisting of pyrroles, imidazoles, pyrazoles, pyrrolines, pyrrolidines, purines, carbazoles, indoles, phenyl indoles, 2,5-dimethylpyrroles, 3-

pentafluorophenyl pyrrole, 4,5,6,7-tetrafluoroindole, 3,4-difluoropyrroles, and combinations thereof.

28. The catalyst system of Claim 21, wherein the polymerization catalyst is a bulky ligand metallocene catalyst having the formulas:

$$L^AL^BMQ_n \text{ and } L^AAL^BMQ_n$$

wherein each of L^A, L^B and Q are bound to M;
each of L^A and L^B are substituted or unsubstituted cyclopentadienyl ligands or cyclopentadienyl-type ligands;
M is a Group 4, 5 or 6 transition metal;
Q is a leaving group; n is 0, 1 or 2; and
A is a divalent bridging group bound to each of L^A and L^B.

29. The catalyst system of Claim 28, wherein M is titanium, zirconium or hafnium.

30. The catalyst system of Claim 21, further comprising an additional activator selected from aluminoxane, modified aluminoxane, tri(n-butyl)ammonium tetrakis(pentafluorophenyl)boron, trisperfluorophenylboron, trisperfluoronaphthyl boron, polyhalogenated heteroborane anions, tris(2,2',2"-nona-fluorobiphenyl) fluoroaluminate, organo-boron-aluminum compounds, dioctadecylmethylammonium-bis(tris(pentafluorophenyl)borane)benzimidazolide and combinations thereof.

31. The catalyst system of Claim 21, wherein the inorganic oxide support is treated with the alkylaluminum compound such that the support has aluminum alkyl groups bonded thereto.

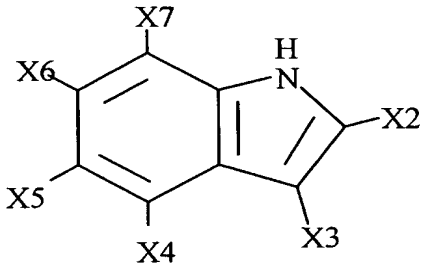
32. The catalyst system of Claim 21, wherein the inorganic oxide support and alkylaluminum compound are combined prior to combining the heterocyclic compound.

33. The catalyst system of Claim 21, wherein the combination of the heterocyclic compound and the product of the combination of the alkylaluminum and inorganic oxide support is heated.

34. The catalyst system of Claim 21, wherein the catalyst system is combined in a polymerization reactor with olefins to produce a polyolefin having a melt index ranging from 0.01 to 100 dg/min and a PDI (Mw/Mn) value of greater than 1.5 to 15; wherein the olefins are ethylene and an olefin selected from C_4 to C_{12} olefins.

35. A polymerization process comprising combining ethylene, at least one C_4 to C_{12} α-olefin and a supported catalyst system; the supported catalyst system prepared by combining a heterocyclic compound with an aluminoxane or an alkylaluminum compound with a support material such that the support material contains aluminum alkyl groups bonded thereto.

36. The process of Claim 35, wherein the heterocyclic compound is an indole represented by:



Formula (I)

wherein each of X2 to X7 is independently selected from the group consisting of hydrogen, halogen, an alkyl group, a halogenated or partially halogenated alkyl group, an aryl group, a halogenated or partially halogenated aryl group, an alkoxide group, a halogenated or partially halogenated alkoxide group, an aryloxide group, a halogenated or partially halogenated aryloxide group, an aryl substituted alkyl group, and a halogenated or partially halogenated aryl substituted alkyl group.

37. The process of Claim 35, further comprising a support material.

38. The process of Claim 35, wherein the aluminum containing compound is an alumoxane or an aluminum alkyl compound represented by the formula AlR_3 wherein each R is independently a substituted or unsubstituted alkyl group or a substituted or unsubstituted aryl group.

39. The process of Claim 35, wherein the aluminum containing compound is an alumoxane or an aluminum alkyl compound represented by the formula AlR_3 wherein each R is independently a substituted or unsubstituted alkyl group.

40. The process of Claim 35, wherein the heterocyclic compound is selected from the group consisting of pyrroles, imidazoles, pyrazoles, pyrrolines, pyrrolidines, purines, carbazoles, indoles, phenyl indoles, 2,5-dimethylpyrroles, 3-pentafluorophenyl pyrrole, 4,5,6,7-tetrafluoroindole, 3,4-difluoropyrroles, and combinations thereof.

41. The process of Claim 35, wherein the heterocyclic compound is substituted with one or more substituent groups selected from the group consisting of a halogen atom, and a halogen atom containing group.

42. The process of Claim 41, wherein the halogen atom or the halogen atom group comprises chlorine, fluorine or bromine.

43. The process of Claim 42, wherein the support material is treated with the alumoxane or the alkylaluminum compound such that the support has aluminum alkyl groups bonded thereto.